Santa Clara Valley
Water District

FY 2012
RECHARGE WATER QUALITY REPORT

Front Cover: District staff prepares to collect a recharge water quality sample from a creek.

FY 2012
Recharge Water Quality Report

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FY 2012 RECHARGE WATER QUALITY REPORT

Executive Summary

This Fiscal Year (FY) 2012 Recharge Water Quality Evaluation summarizes the fourth year of water quality characterization of selected in-stream and off-stream groundwater recharge facilities managed by the Santa Clara Valley Water District (District). This project supports Board Water Supply Objective 2.1.1: "Aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and salt water intrusion." The primary objectives of this project are to characterize water quality in the District's groundwater recharge facilities and to identify parameters of concern that may impact groundwater quality. As more data are collected and evaluated, this will allow for an assessment of the potential need for changes in the groundwater monitoring program and/or recharge program.

The District actively replenishes the Santa Clara and Llagas Subbasins with local and imported water to ensure a reliable supply of water and prevent the recurrence of permanent land subsidence. Between 2009 and 2011, the District recharged an average of 100,000 acre-feet of water[1]. Since most of the groundwater pumped comes from the District's managed recharge program, the quality of the recharge water is verified through ongoing monitoring. Recharge facility monitoring supplements other District monitoring efforts, including sampling of reservoirs and groundwater wells. Sources of water used for groundwater recharge include local runoff captured in reservoirs and local watersheds, as well as water imported into the county from the Sacramento-San Joaquin Delta. Depending on the availability of supplies, District facilities may be receiving either local or imported water, or a blend.

Evaluation of the quality of water used for recharge helps to ensure adequate groundwater resources protection. To provide regular sampling of all major recharge systems, the District collects water quality samples from each major system once every three years. In FY 2012, water samples were collected from 12 locations in the Penitencia and South County recharge systems. The annual recharge capacity of the Penitencia and South County recharge systems is approximately 6,800 and 22,000 acre-feet, respectively[2]. In FY 2012, the District collected samples from Overfelt Pond, Penitencia Creek, Penitencia Pond, Silver Creek, Church Pond, Llagas Creek, and Uvas Creek representing both in-stream and off-stream facilities. Samples were collected from each location over three events in October 2011 (dry season), January 2012 (wet season), and April 2012 (wet season).

Parameters analyzed at all sites include major and minor ions, trace elements (metals), total dissolved solids (TDS), alkalinity, and field measurements of flow rate, temperature, pH, specific conductance, dissolved oxygen, turbidity and oxygen reduction potential. These parameters were selected to evaluate the overall recharge water quality and identify any potential adverse impacts to groundwater. Additionally, samples from selected facilities were tested for semi-volatile and volatile organic compounds during the wet season based on the proximity and types of potentially contaminating land use activities.

Although recharge water is not subject to regulatory drinking water standards, the monitoring results were compared to established drinking water standards (where applicable) to provide context. In FY 2012, none of the recharge water quality samples analyzed had parameters present above health-based maximum contaminant levels (MCLs). The aesthetic-based secondary maximum contaminant levels (SMCLs) for manganese, TDS, and specific conductance were exceeded in Silver Creek (part of the Penitencia recharge system) for all three sampling events. Manganese was also above the SMCL at one of the Llagas Creek sampling locations for two of the three events. No other sites had parameters above SMCLs; in fact, most were well below these thresholds. There were no volatile or semi-volatile organic compounds detected at any of the sites sampled, and many of the trace metals were also non-detect.

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[1] Santa Clara Valley Water District, Protection and Augmentation of Water Supplies, February 2012.

[2] These estimates assume water is available all year and that ponds are in normal operational condition.

Results for key water quality indicators including TDS, chloride, and nitrate, shows the water quality in the Penitencia and South County recharge systems is generally high and is typically similar to or better than the underlying groundwater quality (Table ES-1). With regard to seasonal variability at the Penitencia recharge system, the median concentration between each sampling event varies as concentrations tend to increase during the wet sampling events. The same seasonal variability was not observed at the South County recharge system, where median concentrations remained similar between each sampling event. The cause for the variability observed in the Penitencia recharge system is due in part to higher concentrations observed at Silver Creek.

The recharge systems sampled do not appear to be impacted by runoff or trace metals, although there is some evidence of increased salinity (chloride, sulfate, and TDS) in Silver Creek that may warrant further monitoring as discussed in Chapter 2. Some variations in the water quality indicators are observed and are expected based on changes in source water, including the contribution of runoff. Overall, recharge water quality samples analyzed in FY 2012 indicate the recharge water is generally of high quality and does not appear to be considerably impacted by runoff, trace metals, or salinity with the exceptions noted above.

Table ES-1 Comparison of Median Recharge Water Quality and Groundwater Quality

Parameter		Aluminum	Chloride	Iron	Nitrate (as NO_3)	pH[3]	Sulfate	TDS	Total Alkalinity (as $CaCO_3$)
Units		mg/L	mg/L	mg/L	mg/L	pH Units	mg/L	mg/L	mg/L
Penitencia Recharge System Median Water Quality[1]		12.3	76	15.7	2.35	7.5	53.5	332	115
Santa Clara Subbasin Median Groundwater Quality[2]	Shallow Zone	38.5	47	41.4	2.9	7.2	51.5	451	268
	Principal Zone	33.7	44.5	62.3	15	7.3	43	380	220
South County Recharge System Median Water Quality[1]		<20	10	19.4	0.88	7.1	23.3	218	143
Llagas Subbasin Median Groundwater Quality[2]	Shallow Zone	23.9	44	<20	48	7	47.1	426	220
	Principal Zone	27.8	32	41.3	21.2	7.31	30.5	360	200

Notes:

1. Values shown represent the median for all samples collected over three events in FY 2012. The Penitencia recharge system contains facilities that recharge the Santa Clara Subbasin and the South County recharge system contains facilities that recharge the Llagas Subbasin.
2. Santa Clara Valley Water District, 2011 Groundwater Quality Report, June 2012.
3. Recharge water quality pH data are measured in the field while groundwater values are measured in the laboratory.

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FY 2012 RECHARGE WATER QUALITY REPORT
Introduction

1.1 PURPOSE

The Santa Clara Valley Water District (District) monitors the quality of water used at selected in-stream and off-stream recharge facilities in support of Board Water Supply Objective 2.1.1: "Aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and salt water intrusion." This report summarizes the recharge water quality sampling conducted for Fiscal Year 2012 (FY 2012), including sampling events conducted in the Penitencia and South County recharge systems in October 2011, January 2012, and March 2012 in accordance with the Recharge Water Quality Monitoring Plan (Monitoring Plan)[1].

The primary objectives of this monitoring are to characterize recharge water quality and help ensure that groundwater quality is not adversely impacted as a result of managed recharge, the sources of which include water imported from the Sacramento-San Joaquin Delta, local reservoir watersheds, and surface runoff from surrounding areas. Specific objectives are to:

- Monitor for parameters of concern that have the potential to impact groundwater.
- Characterize recharge water quality at select facilities, including the comparison between water quality and established drinking water standards.
- Assess the need for changes in the groundwater monitoring programs and/or groundwater recharge program.

This report characterizes the water quality at the recharge facilities to assess its potential effects on groundwater quality. This report does not evaluate the fate and transport of the recharge water, including any potential geochemical reactions in the subsurface or impacts such as infiltration capacity reduction.

1.2 BACKGROUND

The District's managed recharge program uses untreated local and imported water to replenish the Santa Clara and Llagas Groundwater Subbasins (Basins 2-9.02 and 3-3.01)[2] through various recharge facilities (Figure 1-1). The District currently recharges about 100,000 acre-feet of local and imported water each year[3] and this managed recharge accounts for the majority of groundwater used in the county. The District recharge facility network includes more than 390 acres of constructed recharge ponds and 90 miles of local creeks. Generally, in-stream recharge facilities (creeks) convey water to the pond systems via turn outs from their respective reservoirs. The sources of water used for recharge include local runoff captured in 10 local reservoirs and water imported from the Sacramento-San Joaquin Delta. Incidental runoff also enters recharge facilities locally.

The recharge facilities are grouped into the following seven major systems[4]: the Stevens Creek, Westside, Los Gatos, Guadalupe, Coyote, Penitencia, and South County recharge systems. Each system consists of multiple ponds and stream reaches and is defined largely on geography and contributing watershed. For example, the ponds and creeks in the Los Gatos recharge system generally receive water from Lexington Reservoir via Los Gatos Creek. All recharge systems, except the South County recharge system (which includes Uvas and Llagas Creeks and the Church Ponds), can receive both local and imported water. However, not all facilities within a given system can receive both sources. The source water for these facilities can vary from day to day throughout the year depending on supply availability and other operational factors.

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[1] Santa Clara Valley Water District, Recharge Water Quality Monitoring Plan, February 2012.

[2] California Department of Water Resources, Bulletin 118, 2003.

[3] Santa Clara Valley Water District, Protection and Augmentation of Water Supplies Report, February 2012.

[4] Santa Clara Valley Water District, District Groundwater Recharge Facilities, December 1977.

The District's Watershed Sanitary Survey (WSS) report provides water quality monitoring data from the District's four drinking water reservoirs: Almaden, Calero, Coyote, and Anderson. All four reservoirs also provide water to some recharge facilities. Starting in 1989, the WSS report has been completed once every 5 years, with subsequent completions in 2001 and 2006. The latest WSS report representing the period from 2006 through 2010 was submitted to the California Department of Public Health (CDPH) in December 2011. The 2011 WSS report included monitoring and sampling of dissolved organic carbon, sulfate, total phosphorus, total dissolved solids (TDS), total suspended solids, boron, nitrite, methyl tertiary butyl ether, among others. In this latest WSS report, the District concluded the quality of water in its drinking water reservoirs was similar to previous years reaffirming their high quality.

To help ensure adequate protection of groundwater quality, the District has developed a monitoring program to sample the quality of water at select recharge facilities in order to evaluate potential effects on groundwater. The program's focus is on the more common inorganic parameters and the overall quality of the water used for groundwater replenishment.

Recharge facility monitoring supplements other District monitoring efforts, including sampling of reservoirs and groundwater wells. While the WSS report provides information on the quality of water at the drinking water reservoirs, it does not include all reservoirs used for groundwater recharge and would not capture the influence of potentially contaminating land use activities near recharge facilities. Groundwater quality monitoring measures the quality of water in wells, but does not directly assess recharge water quality since the well water will have a significant groundwater component. Monitoring water at recharge facilities allows for a direct measure of the quality of water being recharged into the groundwater basin and helps to assess any potential effects of local runoff or other land use activities.

To provide regular sampling of all major recharge systems, the District collects water quality samples from each major system once every three years. In FY 2012, water samples were collected from 12 locations in the Penitencia and South County recharge systems. The annual recharge capacity of the Penitencia and South County recharge systems is approximately 6,800 and 22,000 acre-feet, respectively[5].

1.3 FY 2012 SAMPLING SUMMARY

The District collected recharge water quality samples from 12 locations representing the Penitencia and South County recharge systems in FY 2012 (Table 1-1). For each event, sampling was conducted at 6 locations in the Penitencia recharge system and at 6 locations in the South County recharge system (Figure 1-2). Several facilities included two sampling points due primarily to the size of the facility, potential recharge capacity, and the need to obtain a representative sample set to compensate for water quality variation within the water body. In some cases, both upstream and downstream samples were collected to evaluate the influence of runoff from a potential non-point source or potentially contaminating activity (PCA) associated with the adjacent land use, such as those collected at Penitencia Creek near a fleet parking lot.

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[5] These estimates assume water is available all year and that ponds are in normal operational condition.

Samples were collected at the same 12 locations for each event to the extent possible. Exceptions were made at two of the Silver Creek sampling locations, which were substituted with alternate sites due to construction and safety concerns. Sampling was conducted for 3 events during both the dry season and the rainy season to evaluate potential seasonal changes in water quality. Dry season events are assumed to be mostly representative of District releases from reservoirs or pipelines due to minimal rainfall or runoff during those periods. The three sampling events in FY 2012 are summarized below.

- Event 1 - October 24 and 25, 2011 (dry event)
- Event 2 - January 24 through 26, 2012 (wet event)
- Event 3 - March 21 and 22, 2012 (wet event)

The water quality parameters analyzed were selected to determine the overall quality of water used for groundwater recharge, with a focus on common inorganic parameters. Parameters analyzed in FY 2012 included major and minor ions, trace elements, and field measured parameters. These parameters were analyzed for each of the sampling locations for every event. Testing of volatile organic compounds (VOCs) and semi-volatile compounds (SVOCs) was also conducted for one or both wet sampling events at locations near industrial and automotive chemical sources or herbicide/pesticide application areas as shown in Table 1-1. VOCs and SVOCs were tested at these locations to evaluate potential impacts from runoff entering these facilities. A complete list of parameters analyzed can be found in Appendix A.

1.4 INTERPRETATION OF RECHARGE WATER QUALITY RESULTS

The District monitors recharge water quality to characterize the water quality, detect changes, and identify any potentially adverse impacts to groundwater quality. To accomplish this, the District evaluates sampling data against drinking water standards, determines water typing, and analyzes key water quality indicators as compared to background groundwater quality. Drinking water standards are not applicable to recharge water; however, they provide a useful comparison to help indicate potential threats to groundwater quality. Water typing helps to ascertain the general mineral character in the water, which can help to identify changes over time. The following sections provide detailed information on results obtained and significance of each parameter group.

Table 1-1 Summary of FY 2012 Recharge Water Quality Monitoring

Recharge System	Facility Name	Adjacent Land Use	Samples per Facility[1]	Parameters Analyzed
Penitencia	Overfelt Pond	Public park	1	• Major and minor ions • Trace elements • Field parameters • VOCs/SVOCs (March 2012)
Penitencia	Penitencia Creek	Fleet parking lot	2	• Major and minor ions • Trace elements • Field parameters • VOCs/SVOCs (wet events)
Penitencia	Penitencia Pond	Residential, school	1	• Major and minor ions • Trace element • Field parameters
Penitencia	Silver Creek[2]	Park/school, green area, expressway	2	• Major and minor ions • Trace elements • Field parameters • VOCs/SVOCs (wet events)
South County	Church Pond	Scrap yard	1	• Major and minor ions • Trace elements • Field parameters • VOCs/SVOCs (March 2012)
South County	Llagas Creek	Agricultural area, scrap yard/garbage transfer station	2	• Major and minor ions • Trace elements • Field parameters • VOCs/SVOCs (wet events)
South County	Uvas Creek	Agricultural area, golf course, highway	3	• Major and minor ions • Trace elements • Field parameters • VOCs/SVOCs (wet events)

Notes:

1. Indicates the number of samples collected per facility for each event. Three sampling events were conducted in FY 2012.
2. The Silver Creek facility sample locations were changed in both January and March 2012 due to construction and unsafe access.

Figure 1-1 Santa Clara County Groundwater Subbasins

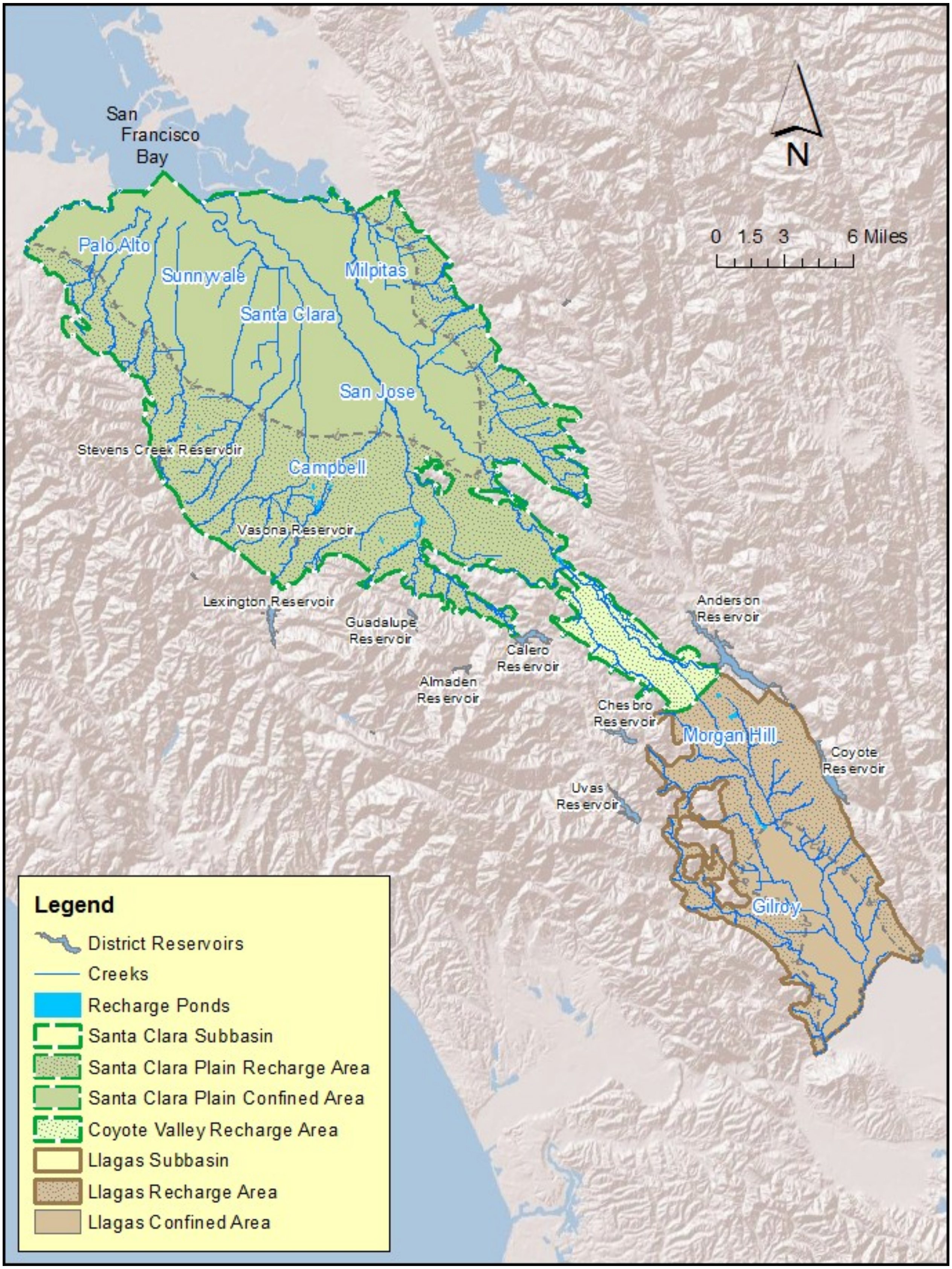
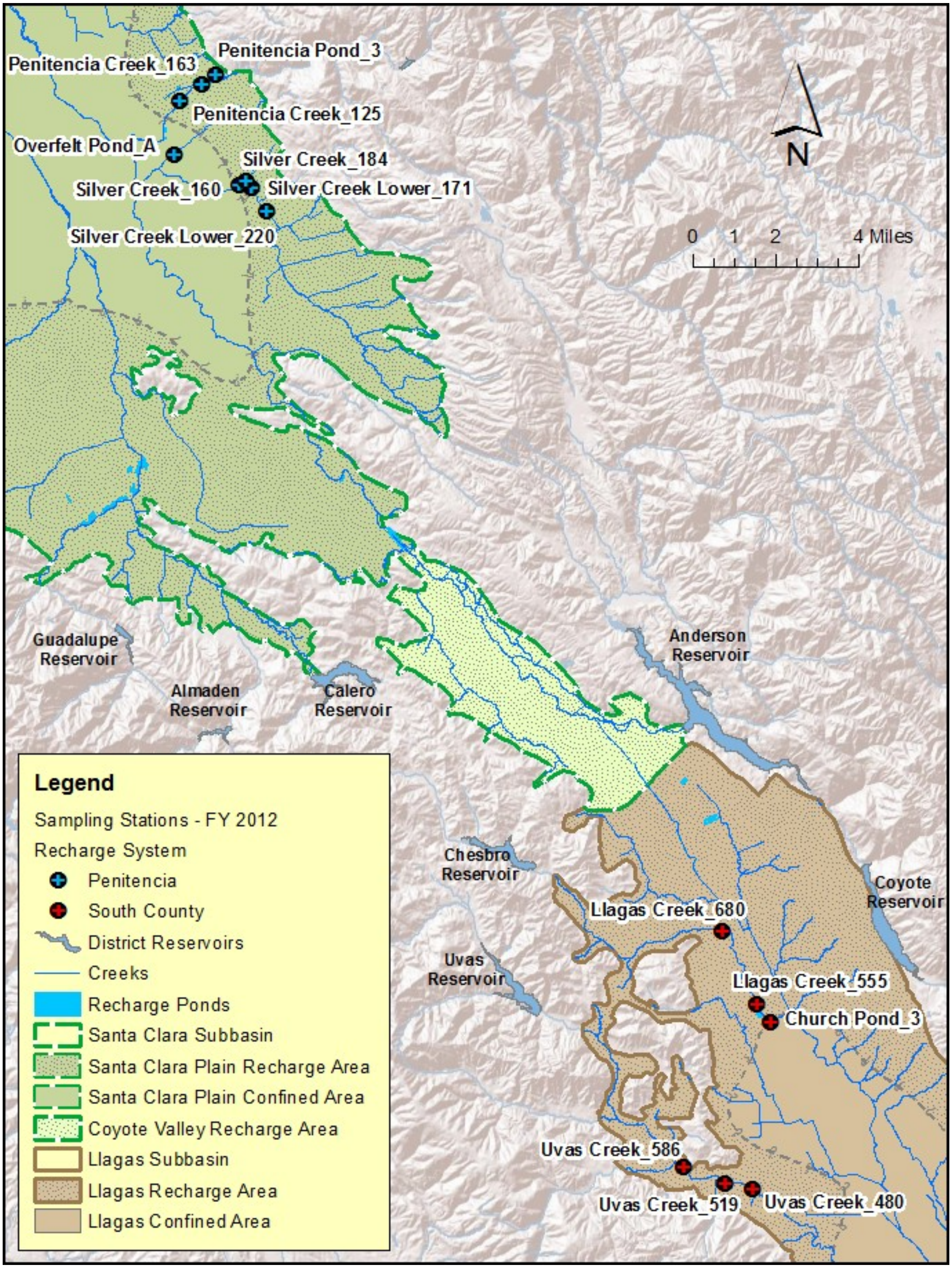


Figure 1-2 FY 2012 Recharge Water Quality Sampling Locations



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FY 2012 RECHARGE WATER QUALITY REPORT

Recharge Water Quality Results

This section summarizes the results from three recharge water quality sampling events conducted in FY 2012 and includes a comparison to drinking water standards, evaluation of water types, and a summary of key water quality indicators, organic compounds, and field parameters.

The FY 2012 results indicate that, for the most part, the water sampled at the Penitencia and South County recharge systems is generally of high quality and no impairment of the underlying groundwater is expected as a result of the District's managed recharge. Silver Creek in the Penitencia recharge system contains elevated concentrations of salts and may warrant additional monitoring as described ahead. A Quality Assurance and Quality Control (QA/QC) evaluation of the data collected and reported by the District laboratory reveals no major discrepancies or concerns and therefore the data is deemed acceptable for the purposes of this report. A complete summary of the QA/QC review is available in Appendix B.

2.1 COMPARISON OF WATER QUALITY RESULTS TO DRINKING WATER STANDARDS

While recharge water is not subject to drinking water standards established by the California Department of Public Health (CDPH), these standards provide context for the sample results as compared to the maximum concentration of specific contaminants that can be present in public water systems. For parameters with known adverse health effects, CDPH has established Maximum Contaminant Levels (MCLs). Although there are no MCLs for lead and copper, concentrations are compared to action levels, as defined in the CDPH Lead and Copper Rule. The CDPH has also established secondary Maximum Contaminant Levels (SMCLs) to address aesthetic issues, such as taste and odor.

Water quality results for all recharge locations sampled during FY 2012 are listed in Tables 2-1 through 2-3. No parameters were detected at concentrations above established health-based MCLs or lead and copper action limits during the FY 2012 sampling. This includes nitrate, aluminum, arsenic, and other trace elements. In addition, many trace elements were not detected.

Aesthetic-based SMCLs were exceeded for total dissolved solids (TDS), specific conductance, and manganese. CDPH has established a SMCL range for TDS with a “recommended” lower limit of 500 milligrams per liter (mg/L) and an upper limit of 1,000 mg/L. Similarly, specific conductance has an SMCL range of 900 micro-Siemens per centimeter (µS/cm) to 1,600 µS/cm. The lower recommended SMCL was exceeded for TDS and specific conductance in all samples collected in Silver Creek, with maximum concentrations of 836 mg/L and 1,400 µS/cm, respectively. In addition, the SMCL for manganese (50 mg/L) was exceeded in all but one of the sampling locations in Silver Creek for all three sampling events and at a Llagas Creek sampling location for two events. The maximum concentration of manganese detected at Silver Creek was 99.6 mg/L and at Llagas Creek it was 72.5 mg/L.

None of the nineteen trace elements for which MCLs and SMCLs exist were detected above their respective standard. Similarly, no other parameters besides those noted above were detected above drinking water standards; in fact, most were well below these thresholds.

2.2 WATER TYPING

Water quality typing is a way to characterize water and can be helpful to understand sources and mixing of different waters. Ideally, the mineral character of the water used for recharge would not be dominated by undesirable ions such as sodium, chloride, and sulfate, which are related to taste and aesthetic issues. Based on reported ion concentrations, water types were determined for each recharge system and each sampling event to ascertain the general mineral character of the water.

The predominant cation in the Penitencia recharge system is sodium and the predominant anion is bicarbonate. This is slightly different than most recharge systems based on past sampling events, which are generally dominated by either the calcium or magnesium cation. The predominance of the sodium cation in the Penitencia recharge system is indicative of more saline water and warrants further investigation. The predominant cation and anion in the South County recharge system is calcium and bicarbonate, respectively, which indicates a similar water type to most other recharge facilities within the county.

The water type is ultimately a function of the specific blend of local water and imported source water delivered to the various recharge facilities at the time of sampling. Although the Penitencia recharge system can receive imported water, Silver Creek only receives local surface water runoff from its contributing watershed area. Land use near Silver Creek is predominately residential with a little commercial and green space (parks and undeveloped) in the area where samples were collected, with upstream land use varying between commercial use, a recreational lake and golf courses.

2.3 KEY WATER QUALITY INDICATORS

Several key water quality indicators were evaluated to help determine the overall quality of water including TDS, chloride, pH, nitrate, sulfate, total alkalinity, aluminum, and iron. The results for the water quality indicators are discussed below and the median concentrations are shown in Tables 2-4 and 2-5. Table 2-6 compares median recharge water quality concentrations to median regional groundwater quality values[1]. In most cases the median concentrations reported at the recharge facilities were lower than the underlying groundwater, with a few exceptions for chloride and sulfate at the Penitencia Recharge System. As expected, most parameter concentrations were lower during the dry sampling events as compared to the wet events. This is primarily due to increased loading from runoff during the winter months.

TDS

TDS is a measure of all substances dissolved in water, and was used to evaluate the quality of water since these substances can affect water taste and plant health. The median TDS value for each sampling event ranged from 172 to 360 mg/L at the Penitencia recharge system and from 215 to 233 mg/L in the South County recharge system (Tables 2-4 and 2-5). Overall, the median TDS concentration at all the sites sampled within the Penitencia and South County recharge systems was 332 and 218 mg/L, respectively. The higher TDS value at the Penitencia recharge system is primarily due to the high TDS concentrations within Silver Creek which ranged from 586 to 836 mg/L for the three sampling events. The elevated levels of TDS in Silver Creek are of concern and may warrant additional monitoring prior to the next planned sampling in FY 2015. TDS at other facilities within the Penitencia recharge system was lower, ranging from 134 to 372 mg/L. TDS levels in the Penitencia and South County recharge systems as a whole indicate high overall quality with respect to dissolved solids since the median value for each recharge system during any one event was below the lower SMCL of 500 mg/L. As shown in Table 2-6, the median TDS value for both the Penitencia and South County recharge systems is lower than underlying groundwater in the Santa Clara and Llagas Subbasins.

Chloride and Sulfate

Chloride and sulfate were used as salinity indicators. As shown in Table 2-4 and 2-5, the median chloride concentration for each sampling event in the Penitencia and South County recharge systems ranged between 24 and 80 mg/L and between 8 and 13 mg/L, respectively. The overall median chloride concentration in the Penitencia recharge system was 76 mg/L, which is somewhat higher than underlying groundwater in the Santa Clara Subbasin (47 and 44.5 mg/L in the shallow and principal aquifer zones, respectively), as shown in Table 2-6. As with TDS, the higher chloride concentrations at the Penitencia recharge system is primarily due to higher chloride concentrations in Silver Creek which ranged from 79 to 118 mg/L. The overall median chloride concentration in the South County recharge system was 10 mg/L, which is lower than the underlying groundwater in the Llagas Subbasin (44 and 32 mg/L for the shallow and principal aquifer zones, respectively). The median chloride concentration for both recharge systems for all events was well below the SMCL of 250 mg/L.

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[1] Santa Clara Valley Water District, 2011 Groundwater Quality Report, June 2012.

The median sulfate concentration for each sampling event in the Penitencia recharge system ranged from 15 to 59 mg/L, while the overall median concentration was 53.5 mg/L, which is slightly higher than the underlying groundwater (51.5 and 43 mg/L in the shallow and principal aquifer zones, respectively). The median concentration for each sampling event for sulfate in the South County system ranged between 21 and 27 mg/L. The overall median concentration was 23.3 mg/L, which is lower than the underlying Llagas Subbasin (47.1 and 30.5 mg/L for the shallow and principal zones, respectively).

In general, chloride and sulfate results do not indicate impairment due to salinity in the Penitencia and South County recharge systems. In light of the elevated TDS, chloride and sulfate concentrations observed at Silver Creek, other parameters like sodium and calcium and magnesium were also evaluated in the context of surface water hardness levels to determine if other minerals were also elevated above background levels. Hardness was chosen because the imported water sources to the District are tested on a daily basis for a limited suite of parameters including among hardness and chloride. Although imported water is not delivered to Silver Creek, this analysis was performed to evaluate the water quality differences between Silver Creek and other facilities in the Penitencia recharge system.

Imported water delivered to the Penitencia recharge system via a turnout at Penitencia Creek (upstream of the sampling locations) and analyzed by the District laboratory, provided limited water quality data for this area. This data includes some of the indicators above, sodium and hardness, and is expected to reflect water quality within the recharge system itself. A review of this data confirms that imported water quality is very similar to the samples collected at the Penitencia and Overfelt Ponds and Penitencia Creek with respect to hardness, chloride, and TDS despite limited imported water releases into the creek during this time. However, the imported water quality is notably different from Silver Creek (Table 2-7).

In addition, limited groundwater quality data within the Silver Creek area was also reviewed. Groundwater quality data obtained from two groundwater wells approximately 600 feet deep reveals similar concentrations for hardness and chloride as compared to Penitencia Creek and the two ponds, but dissimilar values for sodium and TDS. Dissimilar values between groundwater and surface water at Silver Creek were observed for hardness, sodium, and chloride (Table 2-7). Because imported water and groundwater is very similar to surface water sampled at Penitencia Creek and the ponds, and dissimilar water quality is predominantly limited to Silver Creek, the Penitencia recharge system as a whole is not likely being impacted by higher saline-type water coming from Silver Creek. However, this should be confirmed with additional sampling since no existing shallow groundwater monitoring wells near Silver Creek were found as part of this evaluation and no apparent sources were found nearby.

pH

Changes in basic water quality were evaluated using pH since the pH level has a direct impact on the solubility of metals and the dissociation of weak acids and bases in water. As shown in Table 2-6, the median pH levels in both the Penitencia and South County systems were slightly higher than that of the median value for the underlying groundwater. However, the pH for both recharge system falls within the typical range of 6 to 8.5 for natural waters[2].

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[2] Hem, J., Study and Interpretation of Chemical Characteristics of Natural Water, 1985.

Variation in pH values between recharge systems is likely due to the extent of contribution from runoff. In the Penitencia recharge system, sampling locations are located near a park, school, green area and expressway and in the South County recharge system sampling locations are near rural areas, agricultural, industrial and recreational areas.

Nitrate and Alkalinity

Nitrate and alkalinity were used to evaluate potential water quality impacts from runoff. The median nitrate levels in the Penitencia recharge system ranged between 1.1 and 2.9 mg/L (as nitrate) and the median for the South County recharge system ranged between 0.5 and 2.3 mg/L (as nitrate), well below the MCL of 45 mg/L. The median nitrate concentration during the wet events for both recharge systems was around 2.6 mg/L. Nitrate concentrations in the Penitencia recharge system were lower than concentrations in the Santa Clara Subbasin shallow and principal aquifer zones, which were 2.9 and 15 mg/L, respectively (Table 2-6). Water from the South County recharge system was significantly less concentrated in nitrate compared to the Llagas Subbasin shallow and principal aquifer zones, which had nitrate concentrations of 48 and 21.1 mg/L, respectively. The continued recharge of surface water with lower nitrate concentrations is assisting in diluting groundwater concentrations over time.

The median concentration of alkalinity as $CaCO_3$ for the Penitencia and South County recharge systems was 115 mg/L and 143 mg/L, respectively. This is lower than the median concentrations for all aquifer zones in both the Santa Clara and Llagas Subbasins. Between each recharge system and each sampling event, little variation in alkalinity concentrations was observed. Nitrate and alkalinity results from FY 12 do not indicate the presence of impacts from runoff to the recharge facilities.

Aluminum and Iron

Lastly, aluminum and iron were used to represent trace metals and are of interest because these parameters have been present above SMCLs at some locations in previous sampling events. Aluminum concentrations ranged between non-detect (at a reporting limit of 20 mg/L) and 38 mg/L at the Penitencia recharge system while the overall median[3] was 12.3 mg/L (Table 2-4). Aluminum concentrations for each sampling event in the South County recharge system were non-detect (Table 2-5). The overall median in the Penitencia recharge system is lower than the underlying median Santa Clara Subbasin principal and shallow aquifer zone values for aluminum (38.5 and 33.7 mg/L, respectively). The same is true for the South County recharge system, where the median value for groundwater in the shallow and principal aquifer zone was 23.9 and 27.8 mg/L, respectively.

Iron concentrations ranged between non-detect (at a reporting limit of 20 mg/L) and 42.3 mg/L at the Penitencia recharge system, while the overall median[3] was 15.7 mg/L. Iron concentrations in the South County recharge system ranged between non-detect and 51 mg/L, while the overall median[3] was 19.4 mg/L.. The overall median iron concentration in the Penitencia and South County recharge systems is lower than the underlying median values in both aquifer zones of the Santa Clara and Llagas Subbasins (Table 2-6).

2.4 ORGANIC COMPOUNDS

Semi-volatile organic compounds and volatile organic compounds (VOCs) were analyzed at select locations during the wet sampling events in January 2012 and March 2012. No SVOCs or VOCs were detected in any sample. Since all samples were non-detect, detailed results for each location are not presented in this chapter. A list of the VOCs and SVOCs analyzed can be found in Appendix A. The need for continued sampling for VOCs and SVOCs will be evaluated prior to future sampling events.

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[3] The Maximum Likelihood Estimate (MLE) method was used to determine the median concentration. Median concentrations could not be calculated for sampling events where more than 80% of the data was reported as non-detect.

2.4 FIELD PARAMETERS

Field measurements of pH, temperature, turbidity, specific conductance, dissolved oxygen and oxygen reduction potential (ORP) were collected at each location for all sampling events and the results are presented in Table 2-1. Variation of these parameters within each system is illustrated in Figures 2-1 and 2-2. Evaluation of the field data indicates that most of the field parameters fluctuate within a fairly small and expected range from event to event.

Some exceptions to the small variability observed at most facilities include turbidity in both recharge systems and especially for the South County recharge system during the second sampling event, with the highest recorded turbidity at 63.4 Nephelometric Turbidity Units (NTU) at the Church Pond sampling location.

2.5 SUMMARY

As described above, data for key water quality indicators shows the water quality in the Penitencia and South County recharge systems is generally high and is typically similar to or better than the underlying groundwater quality. With regard to seasonal variability at the Penitencia recharge system, the median concentration between each sampling event varies as concentrations tend to increase during the wet sampling events. The same seasonal variability was not observed at the South County recharge system, where median concentrations remained similar between each sampling event. The cause for the variability observed in the Penitencia recharge system is due in part to the higher parameter concentrations observed at Silver Creek.

The recharge systems sampled do not appear to be impacted by runoff or trace metals, although there is some evidence of increased salinity (chloride, sulfate, and TDS) in Silver Creek in the Penitencia recharge system. Some variations in the water quality indicators are observed and are expected based on changes in source water, including the contribution of runoff. It has been well documented that increased loading of solids (suspended and dissolved) often results during and after storm events[4]. Urban runoff can also result in a sharp increase of organic nutrients (i.e., nitrate, carbon, phosphorus, etc)[5]. Other causes of variation could be the effects of dilution and surface water/groundwater mixing. Monitoring of the Penitencia recharge system is scheduled to occur again in FY 2015, but additional sampling of Silver Creek in the near future may be helpful in distinguishing sources of elevated salinity and better understanding natural conditions.

No parameters were detected above established health-based MCLs or lead and copper action limits during the FY 2012 sampling. TDS, specific conductance, and manganese were detected above their respective SMCLs at Silver Creek. Manganese was detected above the SMCL in Llagas Creek in the South County recharge system. No volatile or semi-volatile organic compounds were detected in FY 2012. As described above, additional monitoring of Silver Creek is recommended to ensure groundwater resources are protected.

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[4] EPA, An Overview of Sediment Quality in the United States, 1987.

[5] Pitt, R. and Burton, G., Stormwater Effects Handbook, 2002.

Table 2-1 Water Quality Results – Event 1, October 2011

Penitencia Recharge System Station Name		Penitencia Creek STA125	Penitencia Creek STA163	Silver Creek STA160	Silver Creek STA184	Overfelt Pond A	Penitencia Pond #3
	Station ID	4032_125+00	4032_163+00	4026_160+00	4026_184+00	9234_A	9261_3
Parameter	**Result Unit**						
Alkalinity - Total (as $CaCO_3$)	mg/L	73	73	436	439	69	58
Alkalinity - Bicarbonate (as $CaCO_3$)	mg/L	73	73	436	439	69	58
Alkalinity - Carbonate (as $CaCO_3$)	mg/L	<5	<5	<5	<5	<5	<5
Alkalinity - Hydroxide (as $CaCO_3$)	mg/L	<5	<5	<5	<5	<5	<5
Aluminum	µg/L	<20	<20	<20	33.38	<20	<20
Antimony	µg/L	<2	<2	<2	<2	<2	<2
Arsenic	µg/L	<2	<2	<2	<2	<2	<2
Barium	µg/L	31.60	32.28	130	130	32.78	27.48
Beryllium	µg/L	<1	<1	<1	<1	<1	<1
Bicarbonate (as $CaCO_3$)	mg/L	89	89	532	535	84	70
Boron	µg/L	288	325	346	340	219	113
Bromide	mg/L	<0.05	<0.05	0.24	0.21	0.06	0.05
Cadmium	µg/L	<1	<1	<1	<1	<1	<1
Calcium (as Ca)	mg/L	14.1	14.2	98.8	101	14	12.5
Calcium (as $CaCO_3$)	mg/L	35.3	35.4	247	253	35	31.4
Carbonate Alkalinity	mg/L	<5	<5	<5	<5	<5	<5
Chloride	mg/L	24	24	110	108	22	20
Chromium	µg/L	<1	<1	<1	<1	<1	<1
Cobalt	µg/L	<2	<2	<2	<2	<2	<2
Copper	µg/L	3.19	3.00	<2	<2	3.77	2.77
Fluoride (Natural Source)	mg/L	0.1	0.11	0.41	0.41	0.11	0.1
Hydroxide Alkalinity	mg/L	<5	<5	<5	<5	<5	<5
Iron	µg/L	<20	<20	<20	<20	<20	<20
Lead	µg/L	<2	<2	<2	<2	<2	<2
Lithium	µg/L	5.8	6.7	23	24	5	6.2

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter

Table 2-1 Water Quality Results – Event 1, October 2011 (continued)

Penitencia Recharge System Station Name		Penitencia Creek STA125	Penitencia Creek STA163	Silver Creek STA160	Silver Creek STA184	Overfelt Pond A	Penitencia Pond #3
Station ID		4032_125+00	4032_163+00	4026_160+00	4026_184+00	9234_A	9261_3
Parameter	**Result Unit**						
Magnesium	mg/L	7.5	7.7	59.5	61.2	7.6	6.6
Manganese	µg/L	<2	<2	56.4	58.9	<2	<2
Mercury	µg/L	<1	<1	<1	<1	<1	<1
Molybdenum	µg/L	<5	<5	5.2	<5	<5	<5
Nickel	µg/L	<2	<2	2.411	2.27	<2	<2
Nitrate (as NO_3)	mg/L	1.07	1.15	21.90	21.00	0.13	1.12
pH- Field	pH units	6.34	6.45	7.28	7.18	6.65	6.04
Phosphate - Ortho	mg/L	0.1	0.1	0.13	0.12	<0.05	0.1
Potassium	mg/L	1.5	1.5	1.1	1	1.6	1.4
Selenium	µg/L	<5	<5	<5	<5	<5	<5
Silica	mg/L	11.4	11.7	23.8	23.9	11.1	11.6
Silver	µg/L	<2	<2	<2	<2	<2	<2
Sodium	mg/L	25.3	26.4	118	115	23.6	19.2
Source Temperature ° C	° C	18.5	18.9	20.4	19.6	19.2	19.4
Specific Conductance	µs/cm	248	256	1,400	1,380	241	204
Specific Conductance - Field	µs/cm	248	256	1,360	1,350	242	206
Sulfate	mg/L	15	15.7	82.1	82	14.7	12.1
Thallium	µg/L	<1	<1	<1	<1	<1	<1
Total Filterable Residue @ 180° C	mg/L	150	184	782	798	160	134
Turbidity - Field	NTU	5.54	3.49	51.2	33.9	4.5	7.08
Vanadium	µg/L	<3	3.1	4.3	4	3	3.2
Zinc	µg/L	<10	<10	<10	<10	<10	<10

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter; µS/cm = micro Siemens per centimeter; ° C= Degrees Centigrade; NTU = Nephelometric Turbidity

Table 2-1 Water Quality Results – Event 1, October 2011 (continued)

South County Recharge System Station Name		Llagas Creek STA555	Llagas Creek STA680	Uvas Creek STA480	Uvas Creek STA519	Uvas Creek STA586	Church Pond #3
Station ID		5010_555+30	5010_680+00	5018_480+00	5018_519+50	5018_586+30	9244_3
Parameter	Result Unit						
Alkalinity - Total (as $CaCO_3$)	mg/L	150	151	143	143	142	134
Alkalinity - Bicarbonate (as $CaCO_3$)	mg/L	110	151	143	143	142	93
Alkalinity - Carbonate (as $CaCO_3$)	mg/L	40	<5	<5	<5	<5	41
Alkalinity - Hydroxide (as $CaCO_3$)	mg/L	<5	<5	<5	<5	<5	<5
Aluminum	µg/L	<20	<20	<20	<20	<20	<20
Antimony	µg/L	<2	<2	<2	<2	<2	<2
Arsenic	µg/L	<2	<2	<2	<2	<2	<2
Barium	µg/L	47.79	52.27	55.14	56.46	54.16	30.59
Beryllium	µg/L	<1	<1	<1	<1	<1	<1
Bicarbonate (as HCO_3)	mg/L	134	185	175	175	173	114
Boron	µg/L	140	138	111	112	116	148
Bromide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	µg/L	<1	<1	<1	<1	<1	<1
Calcium (as Ca)	mg/L	35	34.9	35.7	34.9	34.8	22.8
Calcium (as $CaCO_3$)	mg/L	87.4	87.2	89.1	87.3	87	56.9
Carbonate Alkalinity	mg/L	24	<5	<5	<5	<5	25
Chloride	mg/L	8	8	8	8	7	9
Chromium	µg/L	<1	<1	<1	<1	<1	<1
Cobalt	µg/L	<2	<2	<2	<2	<2	<2
Copper	µg/L	<2	<2	<2	<2	<2	<2
Fluoride (Natural Source)	mg/L	0.12	0.12	0.13	0.12	0.13	0.1
Hydroxide Alkalinity	mg/L	<5	<5	<5	<5	<5	<5
Iron	µg/L	<20	<20	<20	<20	<20	<20
Lead	µg/L	<2	<2	<2	<2	<2	<2
Lithium	µg/L	<5	<5	<5	<5	6.4	<5

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter

Table 2-1 Water Quality Results – Event 1, October 2011 (continued)

South County Recharge System Station Name		Llagas Creek STA555	Llagas Creek STA680	Uvas Creek STA480	Uvas Creek STA519	Uvas Creek STA586	Church Pond #3
Station ID		5010_555+30	5010_680+00	5018_480+00	5018_519+50	5018_586+30	9244_3
Parameter	**Result Unit**						
Magnesium	mg/L	19.8	19.4	18.5	18	18	21.6
Manganese	µg/L	3.62	52.1	<2	2.32	6.93	<2
Mercury	µg/L	<1	<1	<1	<1	<1	<1
Molybdenum	µg/L	<5	<5	<5	<5	<5	<5
Nickel	µg/L	<2	<2	<2	<2	<2	<2
Nitrate (as NO_3)	mg/L	0.13	0.38	0.63	0.83	0.90	<0.05
pH- Field	pH units	7.41	7.07	7.02	7.06	6.89	8.14
Phosphate - Ortho	mg/L	0.07	0.09	<0.05	<0.05	<0.05	<0.05
Potassium	mg/L	1.4	1.4	1	1	1	1.5
Selenium	µg/L	<5	<5	<5	<5	<5	<5
Silica	mg/L	17.6	18.5	18.4	18.8	19	6.7
Silver	µg/L	<2	<2	<2	<2	<2	<2
Sodium	mg/L	11.8	11.5	12.9	12.8	12.6	12.3
Source Temperature ° C	° C	18.3	17.6	15.2	15.4	15.9	21.2
Specific Conductance	µs/cm	356	358	367	358	358	308
Specific Conductance - Field	µs/cm	351	362	353	351	354	305
Sulfate	mg/L	19.4	19.4	23.3	23.4	23.3	16.2
Thallium	µg/L	<1	<1	<1	<1	<1	<1
Total Filterable Residue @ 180° C	mg/L	212	226	218	212	218	192
Turbidity - Field	NTU	4.97	17.1	1.65	2.37	4.47	17.2
Vanadium	µg/L	3.3	<3	<3	<3	<3	4.6
Zinc	µg/L	<10	<10	<10	<10	<10	<10

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter; µS/cm = micro Siemens per centimeter; ° C= Degrees Centigrade; NTU = Nephelometric Turbidity

Table 2-2 Water Quality Results – Event 2, January 2012

	Penitencia Recharge System Station Name	**Penitencia Creek STA125**	**Penitencia Creek STA163**	**Silver Creek STA220**	**Silver Creek STA184**	**Overfelt Pond A**	**Penitencia Pond #3**
	Station ID	**4032_125+00**	**4032_163+00**	**4026_220+00**	**4026_184+00**	**9234_A**	**9261_3**
Parameter	**Result Unit**						
Alkalinity - Total (as $CaCO_3$)	mg/L	117	115	440	317	97	85
Alkalinity - Bicarbonate (as $CaCO_3$)	mg/L	117	75	440	317	57	44
Alkalinity - Carbonate (as $CaCO_3$)	mg/L	<5	40	<5	<5	40	42
Alkalinity - Hydroxide (as $CaCO_3$)	mg/L	<5	<5	<5	<5	<5	<5
Aluminum	µg/L	<20	<20	21.74	<20	32.17	<20
Antimony	µg/L	<2	<2	<2	<2	<2	<2
Arsenic	µg/L	<2	<2	<2	<2	<2	<2
Barium	µg/L	53.37	50.08	130	91.85	54.56	41.51
Beryllium	µg/L	<1	<1	<1	<1	<1	<1
Bicarbonate (as HCO_3)	mg/L	143	92	537	387	70	53
Boron	µg/L	618	697	334	253	254	149
Bromide	mg/L	0.15	0.13	0.24	0.16	0.05	0.13
Cadmium	µg/L	<1	<1	<1	<1	<1	<1
Calcium (as Ca)	mg/L	26.2	25.7	97.4	68.8	22.5	20.9
Calcium (as $CaCO_3$)	mg/L	65.6	64.2	243	172	56.3	52.4
Carbonate Alkalinity	mg/L	<5	24	<5	<5	24	25
Chloride	mg/L	55	59	105	79	23	48
Chromium	µg/L	2.34	2.47	2.48	2.59	2.52	2.57
Cobalt	µg/L	<2	<2	<2	<2	<2	<2
Copper	µg/L	3.16	2.77	<2	3.30	3.15	2.95
Fluoride (Natural Source)	mg/L	0.13	0.13	0.4	0.32	0.09	0.08
Hardness - Total (as $CaCO_3$)	mg/L	120	120	486	337	104	100
Hydroxide Alkalinity	mg/L	<5	<5	<5	<5	<5	<5
Iron	µg/L	<20	<20	<20	22.93	42.23	<20
Lead	µg/L	<2	<2	<2	<2	<2	<2
Lithium	µg/L	14	16	23	17	6.7	<5

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter

Table 2-2 Water Quality Results – Event 2, January 2012 (continued)

Penitencia Recharge System Station Name		Penitencia Creek STA125	Penitencia Creek STA163	Silver Creek STA220	Silver Creek STA184	Overfelt Pond A	Penitencia Pond #3
	Station ID	4032_125+00	4032_163+00	4026_220+00	4026_184+00	9234_A	9261_3
Parameter	**Result Unit**						
Magnesium	mg/L	14.8	14.6	62.1	42.6	12.2	12.1
Manganese	µg/L	2.47	<2	99.6	88	2.17	<2
Mercury	µg/L	<1	<1	<1	<1	<1	<1
Molybdenum	µg/L	<5	<5	5.6	<5	<5	<5
Nickel	µg/L	2.56	2.50	3.81	3.95	3.33	2.59
Nitrate (as NO_3)	mg/L	1.89	2.10	19.00	14.10	0.19	<0.05
pH- Field	pH units	7.52	7.76	7.24	7.05	7.48	7.83
Phosphate - Ortho	mg/L	0.13	0.15	0.15	0.16	<0.05	<0.05
Potassium	mg/L	2.8	2.8	1.2	1.9	2.3	2.3
Selenium	µg/L	<5	<5	<5	<5	<5	<5
Silica	mg/L	13.3	14.3	23.7	17.8	5.4	8
Silver	µg/L	<2	<2	<2	<2	<2	<2
Sodium	mg/L	56.2	61.9	126	90	25.8	40.1
Source Temperature ° C	° C	11.1	11.7	NA	14.3	11.6	10.4
Specific Conductance	µs/cm	498	527	1,370	998	308	379
Specific Conductance - Field	µs/cm	499	529	NA	1,010	320	387
Sulfate	mg/L	45.1	48.2	87.3	76	26.4	31.3
Thallium	µg/L	<1	<1	<1	<1	<1	<1
Total Filterable Residue @ 180° C	mg/L	288	308	786	582	190	220
Turbidity - Field	NTU	1.87	2.33	NA	32.6	2.61	9.73
Turbidity - Laboratory	NTU	2.1	1.8	18	26	10	11
Vanadium	µg/L	<3	<3	3	<3	<3	<3
Zinc	µg/L	<10	<10	<10	<10	<10	<10

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter; µS/cm = micro Siemens per centimeter; ° C= Degrees Centigrade; NTU = Nephelometric Turbidity

Table 2-2 Water Quality Results – Event 2, January 2012 (continued)

South County Recharge System Station Name		Llagas Creek STA555	Llagas Creek STA680	Uvas Creek STA480	Uvas Creek STA519	Uvas Creek STA586	Church Pond #3
Station ID		5010_555+30	5010_680+00	5018_480+00	5018_519+50	5018_586+30	9244_3
Parameter	**Result Unit**						
Alkalinity - Total (as $CaCO_3$)	mg/L	144	147	140	140	141	164
Alkalinity - Bicarbonate (as $CaCO_3$)	mg/L	104	147	140	140	141	164
Alkalinity - Carbonate (as $CaCO_3$)	mg/L	40	<5	<5	<5	<5	<5
Alkalinity - Hydroxide (as $CaCO_3$)	mg/L	<5	<5	<5	<5	<5	<5
Aluminum	µg/L	<20	<20	<20	<20	<20	<20
Antimony	µg/L	<2	<2	<2	<2	<2	<2
Arsenic	µg/L	<2	<2	<2	<2	<2	<2
Barium	µg/L	47.64	66.71	58.05	57.19	56.74	67.87
Beryllium	µg/L	<1	<1	<1	<1	<1	<1
Bicarbonate (as HCO_3)	mg/L	126	179	171	171	171	201
Boron	µg/L	155	166	105	111	117	142
Bromide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	µg/L	<1	<1	<1	<1	<1	<1
Calcium (as Ca)	mg/L	31.1	32.6	36	36.8	36.6	33.3
Calcium (as $CaCO_3$)	mg/L	77.8	81.4	90.1	92	91.6	83.4
Carbonate Alkalinity	mg/L	24	<5	<5	<5	<5	<5
Chloride	mg/L	16	16	10	10	10	9
Chromium	µg/L	2.87	4.267	2.57	2.58	2.58	2.50
Cobalt	µg/L	<2	<2	<2	<2	<2	<2
Copper	µg/L	3.43	3.96	<2	<2	<2	2.241
Fluoride (Natural Source)	mg/L	0.11	0.1	0.11	0.11	0.14	0.10
Hardness - Total (as CaCO3)	mg/L	165	170	164	162	162	178
Hydroxide Alkalinity	mg/L	<5	<5	<5	<5	<5	<5
Iron	µg/L	34.75	51.21	22.08	23.79	23.53	<20
Lead	µg/L	<2	<2	<2	<2	<2	<2
Lithium	µg/L	<5	<5	<5	<5	<5	<5

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter

Table 2-2 Water Quality Results – Event 2, January 2012 (continued)

South County Recharge System Station Name		**Llagas Creek STA555**	**Llagas Creek STA680**	**Uvas Creek STA480**	**Uvas Creek STA519**	**Uvas Creek STA586**	**Church Pond #3**
Station ID		**5010_555+30**	**5010_680+00**	**5018_480+00**	**5018_519+50**	**5018_586+30**	**9244_3**
Parameter	**Result Unit**						
Magnesium	mg/L	21.9	23.1	18.7	19.1	19.3	22.6
Manganese	µg/L	6.80	72.5	6.00	5.86	5.71	17.64
Mercury	µg/L	<1	<1	<1	<1	<1	<1
Molybdenum	µg/L	<5	<5	<5	<5	<5	<5
Nickel	µg/L	5.59	7.41	3.17	3.21	3.14	3.73
Nitrate (as NO_3)	mg/L	5.70	5.30	2.60	2.50	2.30	0.63
pH - Field	pH units	7.51	6.74	6.75	6.91	6.91	7.02
Phosphate - Ortho	mg/L	0.22	0.22	<0.05	<0.05	<0.05	0.1
Potassium	mg/L	2.4	2.4	1.1	1.1	1.1	2.3
Selenium	µg/L	<5	<5	<5	<5	<5	<5
Silica	mg/L	13.6	14.7	16.8	17.2	17.7	4.8
Silver	µg/L	<2	<2	<2	<2	<2	<2
Sodium	mg/L	11.6	12	13.5	13.8	13.8	11.8
Source Temperature ° C	° C	13	11.5	11	10.1	10.3	13.9
Specific Conductance	µs/cm	353	367	359	358	354	367
Specific Conductance - Field	µs/cm	366	379	372	371	368	380
Sulfate	mg/L	15.3	15.2	30.7	30.9	29.9	19.4
Thallium	µg/L	<1	<1	<1	<1	<1	<1
Total Filterable Residue @ 180° C	mg/L	218	218	212	222	214	218
Turbidity - Field	NTU	13.6	13.3	3.63	4.84	4.61	63.4
Turbidity - Laboratory	NTU	9.9	11	3.3	5	4.1	55
Vanadium	µg/L	3.3	3.7	<3	<3	<3	3.8
Zinc	µg/L	<10	<10	<10	<10	<10	<10

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter; µS/cm = micro Siemens per centimeter; ° C= Degrees Centigrade; NTU = Nephelometric Turbidity

Table 2-3 Water Quality Results – Event 3, March 2012

Penitencia Recharge System Station Name		**Penitencia Creek STA125**	**Penitencia Creek STA163**	**Silver Creek STA220**	**Silver Creek STA171**	**Overfelt Pond A**	**Penitencia Pond #3**
Station ID		**4032_125+00**	**4032_163+00**	**4026_220+00**	**4026_171+50**	**9234_A**	**9261_3**
Parameter	**Result Unit**						
Alkalinity - Total (as $CaCO_3$)	mg/L	114	116	462	461	107	95
Alkalinity - Bicarbonate (as $CaCO_3$)	mg/L	114	116	462	461	67	95
Alkalinity - Carbonate (as $CaCO_3$)	mg/L	<5	<5	<5	<5	40	<5
Alkalinity - Hydroxide (as $CaCO_3$)	mg/L	<5	<5	<5	<5	<5	<5
Aluminum	µg/L	<20	<20	<20	<20	38.18	<20
Antimony	µg/L	<2	<2	<2	<2	<2	<2
Arsenic	µg/L	<2	<2	3	2	<2	<2
Barium	µg/L	54.28	56.25	110	110	56.59	46.40
Beryllium	µg/L	<1	<1	<1	<1	<1	<1
Bicarbonate (as HCO_3)	mg/L	139	142	564	563	81	116
Boron	µg/L	379	389	358	337	469	227
Bromide	mg/L	0.17	0.18	0.33	0.3	0.19	0.19
Cadmium	µg/L	<1	<1	<1	<1	<1	<1
Calcium (as Ca)	mg/L	30.3	30.6	94.1	91.4	26.1	27.4
Calcium (as $CaCO_3$)	mg/L	75.8	76.4	235	229	65.3	68.4
Carbonate Alkalinity	mg/L	<5	<5	<5	<5	24	<5
Chloride	mg/L	77	77	118	118	75	83
Chromium	µg/L	2.72	2.87	2.93	2.99	2.87	2.89
Cobalt	µg/L	<2	<2	<2	<2	<2	<2
Copper	µg/L	6.80	7.35	<2	<2	3.38	10.01
Fluoride (Natural Source)	mg/L	0.12	0.14	0.4	0.39	0.12	0.10
Hardness -Total (as $CaCO_3$)	mg/L	20	151	<10	497	124	143
Hydroxide Alkalinity	mg/L	<5	<5	<5	<5	<5	<5
Iron	µg/L	31.25	30.31	<20	<20	35.58	40.57
Lead	µg/L	<2	<2	<2	<2	<2	<2
Lithium	µg/L	8.6	8.9	23	22	11	<5

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter

Table 2-3 Water Quality Results – Event 3, March 2012 (continued)

	Penitencia Recharge System Station Name	Penitencia Creek STA125	Penitencia Creek STA163	Silver Creek STA220	Silver Creek STA171	Overfelt Pond A	Penitencia Pond #3
	Station ID	4032_125+00	4032_163+00	4026_220+00	4026_171+50	9234_A	9261_3
Parameter	**Result Unit**						
Magnesium	mg/L	17.3	17.4	64.7	61.9	15.3	16.5
Manganese	µg/L	<2	<2	52.4	40.6	<2	<2
Mercury	µg/L	<1	<1	<1	<1	<1	<1
Molybdenum	µg/L	<5	<5	5.4	5.5	<5	<5
Nickel	µg/L	3.15	3.37	3.69	3.85	3.27	3.46
Nitrate (as NO_3)	mg/L	2.60	2.60	19.50	20.40	<0.05	3.30
Oxygen Reduction Potential	mV	290	286	298	305	268	265
Oxygen - Dissolved	mg/L	10	11	9	10	14	12
Ph - Field	pH units	8.18	8.28	7.71	7.77	8.79	8.31
Phosphate - Ortho	mg/L	0.05	<0.05	0.07	<0.05	<0.05	0.07
Potassium	mg/L	3.1	3.1	1.2	1.3	3.3	3.3
Selenium	µg/L	<5	<5	<5	<5	<5	<5
Silica	mg/L	11.8	12.1	22.3	21.1	8.5	12.4
Silver	µg/L	<2	<2	<2	<2	<2	<2
Sodium	mg/L	62.7	63.4	139	136	62.5	61.6
Source Temperature ° C	° C	13.4	13.3	16.1	16.3	15.5	14.3
Specific Conductance	µs/cm	574	594	1,380	1,390	535	570
Specific Conductance - Field	µs/cm	531	538	1,390	1,400	545	590
Sulfate	mg/L	56	57	94.2	93	50.9	60
Thallium	µg/L	<1	<1	<1	<1	<1	<1
Total Filterable Residue @ 180° C	mg/L	348	372	818	836	316	348
Turbidity - Field	NTU	6.18	4.92	25.9	28.4	8.66	4.25
Turbidity - Laboratory	NTU	3.3	2.2	18	12	8	2.6
Vanadium	µg/L	<3	<3	3.1	3.3	<3	<3
Zinc	µg/L	<10	<10	<10	<10	<10	<10

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter; µS/cm = micro Siemens per centimeter; ° C= Degrees Centigrade; NTU = Nephelometric Turbidity

Table 2-3 Water Quality Results – Event 3, March 2012 (continued)

	South County Recharge System Station Name	Llagas Creek STA555	Llagas Creek STA680	Uvas Creek STA480	Uvas Creek STA519	Uvas Creek STA586	Church Pond #3
	Station ID	5010_555+30	5010_680+00	5018_480+00	5018_519+50	5018_586+30	9244_3
Parameter	**Result Unit**						
Alkalinity - Total (as $CaCO_3$)	mg/L	178	184	135	137	136	181
Alkalinity - Bicarbonate (as $CaCO_3$)	mg/L	138	184	135	137	136	141
Alkalinity - Carbonate (as $CaCO_3$)	mg/L	40	<5	<5	<5	<5	40
Alkalinity - Hydroxide (as $CaCO_3$)	mg/L	<5	<5	<5	<5	<5	<5
Aluminum	µg/L	<20	<20	<20	<20	<20	<20
Antimony	µg/L	<2	<2	<2	<2	<2	<2
Arsenic	µg/L	<2	<2	<2	<2	<2	<2
Barium	µg/L	52.89	52.22	60.91	60.48	63.02	68.32
Beryllium	µg/L	<1	<1	<1	<1	<1	<1
Bicarbonate (as HCO_3)	mg/L	169	224	165	167	166	171
Boron	µg/L	170	171	106	110	110	154
Bromide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	µg/L	<1	<1	<1	<1	<1	<1
Calcium (as Ca)	mg/L	36	36.2	34	33.9	35.2	35.9
Calcium (as $CaCO_3$)	mg/L	89.9	90.4	84.9	84.8	88	89.6
Carbonate Alkalinity	mg/L	24	<5	<5	<5	<5	24
Chloride	mg/L	16	15	13	13	13	11
Chromium	µg/L	3.071	2.96	3.05	3.13	3.12	3.23
Cobalt	µg/L	<2	<2	<2	<2	<2	<2
Copper	µg/L	2.4	2.09	<2	<2	<2	2.88
Fluoride (Natural Source)	mg/L	0.09	0.09	0.11	0.1	0.1	0.12
Hardness -Total (as $CaCO_3$)	mg/L	196	203	<10	161	160	194
Hydroxide Alkalinity	mg/L	<5	<5	<5	<5	<5	<5
Iron	µg/L	<20	20.41	20.52	25.99	23.54	<20
Lead	µg/L	<2	<2	<2	<2	<2	<2
Lithium	µg/L	<5	<5	<5	<5	<5	<5

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter

Table 2-3 Water Quality Results – Event 3, March 2012 (continued)

	South County Recharge System Station Name	Llagas Creek STA555	Llagas Creek STA680	Uvas Creek STA480	Uvas Creek STA519	Uvas Creek STA586	Church Pond #3
	Station ID	5010_555+30	5010_680+00	5018_480+00	5018_519+50	5018_586+30	9244_3
Parameter	**Result Unit**						
Magnesium	mg/L	26.1	26.1	17.8	17.7	19	25.3
Manganese	µg/L	<2	27.4	7.32	7.26	9.24	2.9
Mercury	µg/L	<1	<1	<1	<1	<1	<1
Molybdenum	µg/L	<5	<5	<5	<5	<5	<5
Nickel	µg/L	4.62	4.62	3.37	3.45	3.48	3.82
Nitrate (as NO_3)	mg/L	0.86	0.82	3.70	3.80	4.80	0.22
Oxygen Reduction Potential	mV	263	292	291	290	307	239
Oxyen - Dissolved	mg/L	15	10	11	11	14	17
Ph - Field	pH units	8.63	7.93	7.61	7.41	7.15	8.71
Phosphate - Ortho	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Potassium	mg/L	1.7	1.6	1.1	1.1	1.1	2.2
Selenium	µg/L	<5	<5	<5	<5	<5	<5
Silica	mg/L	9.6	11.3	17.7	18	19.1	13.9
Silver	µg/L	<2	<2	<2	<2	<2	<2
Sodium	mg/L	13.5	12.9	14.8	14.9	15.6	12.2
Source Temperature °C	°C	18.4	14.6	12.5	11.7	11.6	15.3
Specific Conductance	µs/cm	409	427	362	361	362	393
Specific Conductance - Field	µs/cm	368	426	354	369	373	400
Sulfate	mg/L	16.1	15.9	29.3	29.5	30.1	23.4
Thallium	µg/L	<1	<1	<1	<1	<1	<1
Total Filterable Residue @ 180° C	mg/L	240	252	234	230	218	232
Turbidity - Field	NTU	6.9	12	8	8.9	9.1	26
Turbidity - Laboratory	NTU	3.6	<3	<3	<3	<3	7.1
Vanadium	µg/L	<10	<10	<10	<10	<10	<10
Zinc	µg/L	<10	<10	<10	<10	<10	<10

Notes: µg/l = micrograms per liter; mg/l = milligrams per liter; µS/cm = micro Siemens per centimeter; ° C= Degrees Centigrade; NTU = Nephelometric Turbidity

Table 2-4 Penitencia Recharge System Water Quality Indicator Median Values[1]

Parameter	Units	Event 1 October 2011 (Dry Event)	Event 2 January 2012 (Wet Event)	Event 3 March 2012 (Wet Event)	MCL	SMCL
Aluminum	mg/L	<20[3]	16.91[2]	<20[3]	1000	200
Chloride	mg/L	24	57	80	-	250
Iron	mg/L	<20[3]	15.37	26.52	-	300
Nitrate (as NO3)	mg/L	1.14	2.00	2.95	45	-
pH - Field	pH Units	6.55	7.5	8.23	-	6.5-8.5
Sulfate	mg/L	15.35	46.65	58.5	-	250
TDS	mg/L	172	298	360	-	500
Total Alkalinity (as $CaCO_3$)	mg/L	73	116	115	-	-

Notes:

mg/L = milligrams per liter; MCL= Maximum Contaminant Level; SMCL= Secondary Maximum Contaminant Level

1. Concentrations shown are calculated median concentrations of all facilities for each event.
2. The Maximum-Likelihood Estimation (MLE) method was used to calculate the median where more than 50% of the data was non-detect.
3. When more than 80% of the data was non-detect, the median cannot be calculated and is reported as less than the reporting limit (e.g., <20).

Table 2-5 South County Recharge System Water Quality Indicator Median Values[1]

Parameter	Units	Event 1 October 2011 (Dry Event)	Event 2 January 2012 (Wet Event)	Event 3 March 2012 (Wet Event)	MCL	SMCL
Aluminum	mg/L	<20[2]	<20[2]	<20[2]	1000	200
Chloride	mg/L	8	10	13	-	250
Iron	mg/L	<20[2]	26.6	20.97	-	300
Nitrate (as NO3)	mg/L	0.5	2.55	2.28	45	-
pH - Field	pH Units	7.07	6.91	7.77	-	6.5-8.5
Sulfate	mg/L	21.35	24.65	26.35	-	250
TDS	mg/L	215	218	233	-	500
Total Alkalinity (as CaCO3)	mg/L	143	142.5	157.5	-	-

Notes:

mg/L = milligrams per liter; MCL= Maximum Contaminant Level; SMCL= Secondary Maximum Contaminant Level

1. Concentrations shown are calculated median concentrations of all facilities for each event.
2. All reported values were non-detect. Value shown is the reporting limit for that parameter.

Table 2-6 Comparison of Median Recharge Water Quality and Groundwater Quality

	Parameter	Aluminum	Chloride	Iron	Nitrate (as NO_3)	pH[3]	Sulfate	TDS	Total Alkalinity (as $CaCO_3$)
	Units	mg/L	mg/L	mg/L	mg/L	pH Units	mg/L	mg/L	mg/L
Penitencia Recharge System Median Water Quality[1]		12.3	76	15.7	2.35	7.5	53.5	332	115
Santa Clara Subbasin Median Groundwater Quality[2]	Shallow Zone	38.5	47	41.4	2.9	7.2	51.5	451	268
	Principal Zone	33.7	44.5	62.3	15	7.3	43	380	220
South County Recharge System Median Water Quality[1]		<20	10	19.4	0.88	7.1	23.3	218	143
Llagas Subbasin Median Groundwater Quality[2]	Shallow Zone	23.9	44	<20	48	7	47.1	426	220
	Principal Zone	27.8	32	41.3	21.2	7.31	30.5	360	200

Notes:

1. Values shown represent the median for all samples collected over three events in FY 2012. The Penitencia recharge system contains facilities that recharge the Santa Clara Subbasin and the South County recharge system contains facilities that recharge the Llagas Subbasin.
2. Santa Clara Valley Water District, 2011 Groundwater Quality Report, June 2012.
3. Recharge water quality pH data are measured in the field while groundwater values are measured in the laboratory.

Table 2-7 Select Water Quality Indicator Source Comparison

Parameter	Imported Water Range[1]	Groundwater Range[2]	Penitencia Recharge System Range[3]	Silver Creek Range
Hardness (mg/L as $CaCO_3$)	56-142	101-184	58-151	337-504
Sodium (mg/L)	NA	160-236	19-64	90-139
Chloride (mg/L)	20-87	37-57	20-77	79-118
TDS (mg/L)	110-370[4]	644-740	125-372	582-836

Notes:

1. Based on District laboratory analytical results for event sampling dates
2. Based on water quality data from two production wells in the vicinity of Silver Creek measured between 1995 and 2009
3. Based on all concentrations reported at all facilities within the Penitencia Recharge System other than Silver Creek in FY2012
4. Calculated value based on specific conductance values

NA= No data available

Table 2-8 Field Parameters Measured

Recharge System	Station ID	Station Name	Date	Oxidation Reduction Potential[1]	Oxygen, Dissolved	pH, Field	Source Temperature	Turbidity, Field	Specific Conductance
				(mV)	(mg/L)	(pH units)	(°C)	(NTU)	(mS/cm x 10)
Penitencia	4026_160+00	Silver Creek STA160	10/24/2011	NA	NR	7.28	20.4	51.2	13.6
	4026_184+00	Silver Creek STA184	10/24/2011	NA	NR	7.18	19.6	33.9	13.5
	4032_125+00	Penitencia Creek STA125	10/24/2011	NA	NR	6.34	18.5	5.54	2.48
	4032_163+00	Penitencia Creek STA163	10/24/2011	NA	NR	6.45	18.9	3.49	2.56
	9234_A	Overfelt Pond A	10/24/2011	NA	NR	6.65	19.2	4.5	2.42
	9261_3	Penitencia Pond #3	10/24/2011	NA	NR	6.04	19.4	7.08	2.06
	4026_184+00	Silver Creek STA184	1/24/2012	NA	NR	7.05	14.3	32.6	10.1
	4032_125+00	Penitencia Creek STA125	1/24/2012	NA	NR	7.52	11.1	1.87	4.99
	4032_163+00	Penitencia Creek STA163	1/24/2012	NA	NR	7.76	11.7	2.33	5.29
	9234_A	Overfelt Pond A	1/24/2012	NA	NR	7.48	11.6	2.61	3.2
	9261_3	Penitencia Pond #3	1/24/2012	NA	NR	7.83	10.4	9.73	3.87
	4026_220+00	Silver Creek STA220	1/26/2012	NA	NR	7.24	16	20.5	13.8
	4026_171+50	Silver Creek STA171	3/22/2012	305	10	7.77	16.3	28.4	14
	4026_220+00	Silver Creek STA220	3/22/2012	298	9	7.71	16.1	25.9	13.9
	4032_125+00	Penitencia Creek STA125	3/22/2012	290	10	8.18	13.4	6.18	5.31
	4032_163+00	Penitencia Creek STA163	3/22/2012	286	11	8.28	13.3	4.92	5.38
	9234_A	Overfelt Pond A	3/22/2012	268	14	8.79	15.5	8.66	5.45
	9261_3	Penitencia Pond #3	3/22/2012	265	12	8.31	14.3	4.25	5.9

Notes:
NA= not available since ORP was added to the field measurements starting in March 2012; NR= Dissolved oxygen not reported due to a quality control concern involving an expired reagent used on these dates; mV=milli volts; mg/L= milligrams per liter; mS/cm= milli-Siemens per centimeter; NTU=Nephelometric Turbidity Units; °C=degrees Celsius

Table 2-8 Field Parameters Measured (continued)

Recharge System	Station ID	Station Name	Date	Oxidation Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH, Field (pH units)	Source Temperature (ºC)	Turbidity, Field (NTU)	Specific Conductance (mS/cm x 10)
South County	5010_555+30	Llagas Creek STA555	10/25/2011	NA	NR	7.41	18.3	4.97	3.51
	5010_680+00	Llagas Creek STA680	10/25/2011	NA	NR	7.07	17.6	17.1	3.62
	5018_480+00	Uvas Creek STA480	10/25/2011	NA	NR	7.02	15.2	1.65	3.53
	5018_519+50	Uvas Creek STA519	10/25/2011	NA	NR	7.06	15.4	2.37	3.51
	5018_586+30	Uvas Creek STA586	10/25/2011	NA	NR	6.89	15.9	4.47	3.54
	9244_3	Church Pond #3	10/25/2011	NA	NR	8.14	21.2	17.2	3.05
	5010_555+30	Llagas Creek STA555	1/25/2012	NA	NR	7.51	13	13.6	3.66
	5010_680+00	Llagas Creek STA680	1/25/2012	NA	NR	6.74	11.5	13.3	3.79
	5018_480+00	Uvas Creek STA480	1/25/2012	NA	NR	6.75	11	3.63	3.72
	5018_519+50	Uvas Creek STA519	1/25/2012	NA	NR	6.91	10.1	4.84	3.71
	5018_586+30	Uvas Creek STA586	1/25/2012	NA	NR	6.91	10.3	4.61	3.68
	9244_3	Church Pond #3	1/25/2012	NA	NR	7.02	13.9	63.4	3.8
	5010_555+30	Llagas Creek STA555	3/21/2012	263	15	8.63	18.4	NA	3.68
	5010_680+00	Llagas Creek STA680	3/21/2012	292	10	7.93	14.6	NA	4.26
	5018_480+00	Uvas Creek STA480	3/21/2012	291	11	7.61	12.5	NA	3.54
	5018_519+50	Uvas Creek STA519	3/21/2012	290	11	7.41	11.7	NA	3.69
	5018_586+30	Uvas Creek STA586	3/21/2012	307	14	7.15	11.6	NA	3.73
	9244_3	Church Pond #3	3/21/2012	239	17	8.71	15.3	NA	4

Notes:
NA= not available since ORP was added to the field measurements starting in March 2012; NR= Dissolved oxygen not reported due to a quality control concern involving an expired reagent used on these dates; mV=milli volts; mg/L= milligrams per liter; mS/cm= milli-Siemens per centimeter; NTU=Nephelometric Turbidity Units; ºC=degrees Celsius

Figure 2-1 Penitencia Recharge System Field Parameter Box Plots

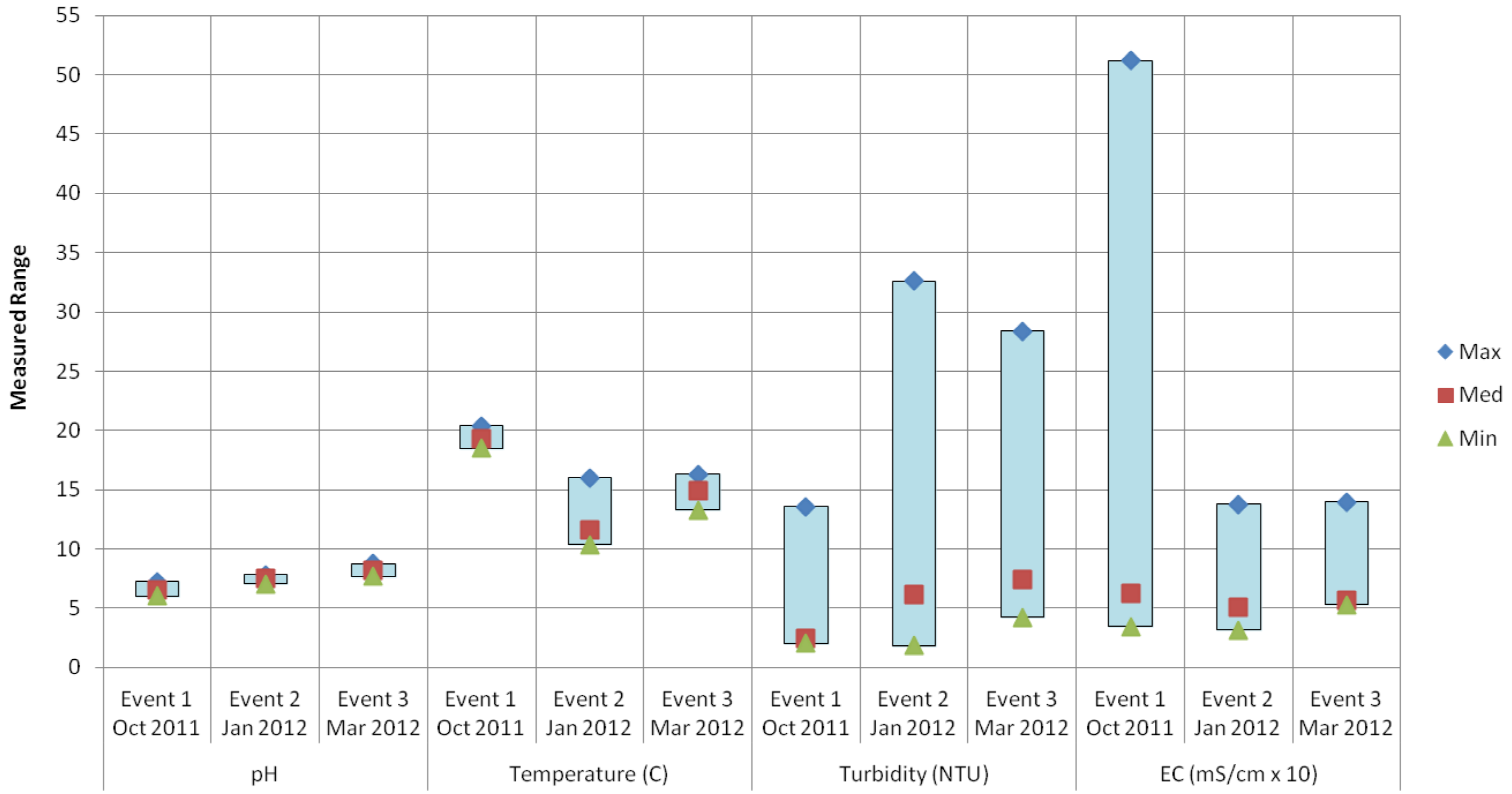
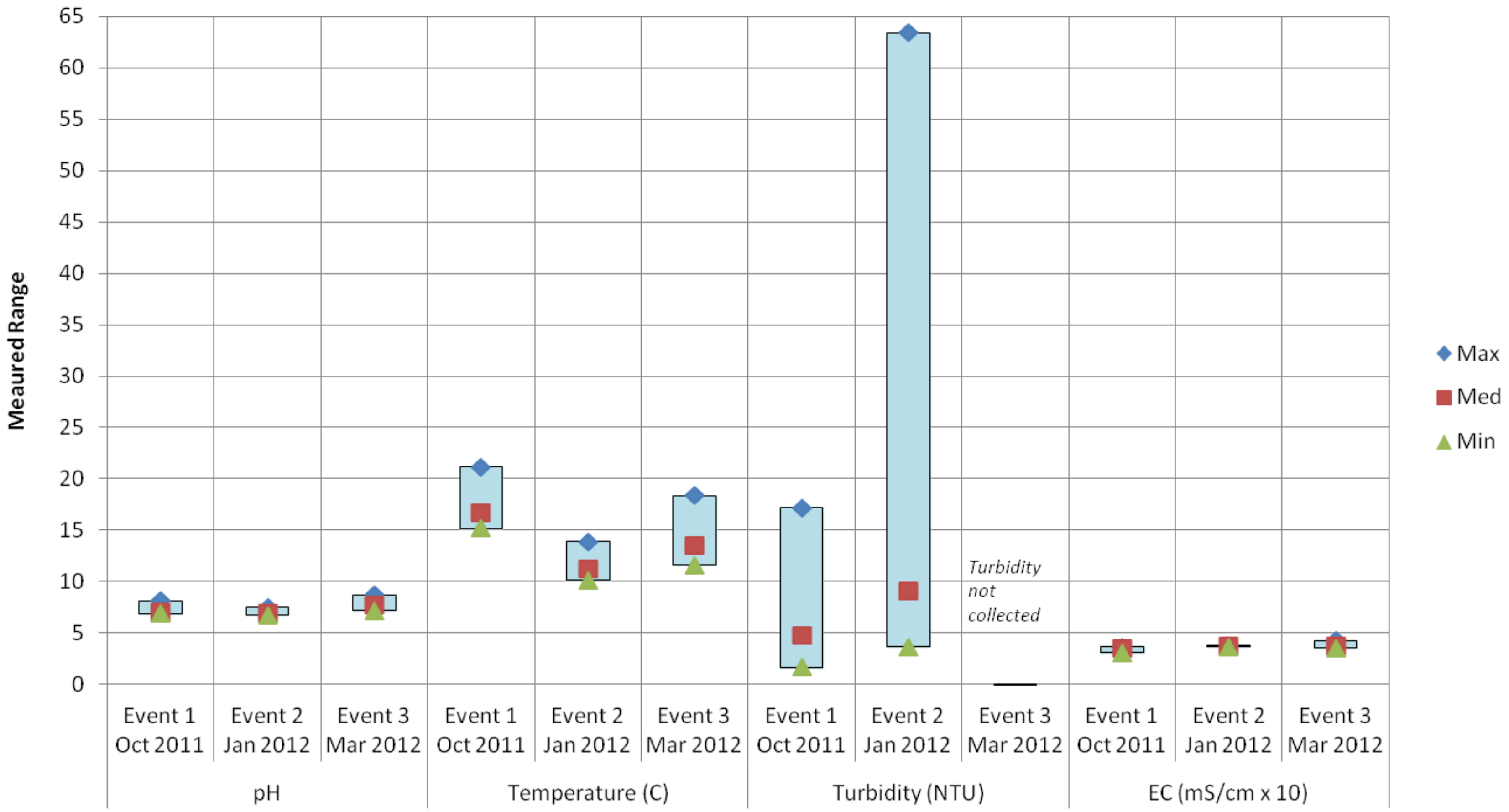


Figure 2-2 South County Recharge System Field Parameter Box Plots



APPENDIX A – LIST OF ORGANIC COMPOUNDS ANALYZED AT SELECT SITES

Parameter	Units	Threshold Type	Threshold
EPA 200.7 - Metals			
Aluminum	µg/L	MCL (SMCL)	200 (1000)
Boron	µg/L	NA	NA
Calcium	mg/L	NA	NA
Calcium (as $CaCO_3$)	mg/L	NA	NA
Iron	µg/L	SMCL	300
Lithium	µg/L	NA	NA
Magnesium	mg/L	NA	NA
Potassium	mg/L	NA	NA
Silica	mg/L	NA	NA
Sodium	mg/L	NA	NA
Zinc	µg/L	SMCL	5000
EPA 200.8 - Trace Elements			
Antimony	µg/L	MCL	6
Arsenic	µg/L	MCL	10
Barium	µg/L	MCL	1000
Beryllium	µg/L	MCL	4
Cadmium	µg/L	MCL	5
Chromium	µg/L	MCL	50
Cobalt	µg/L	NA	NA
Copper	µg/L	SMCL	1000
Lead	µg/L	AL	50
Manganese	µg/L	SMCL	50
Molybdenum	µg/L	NA	NA
Nickel	µg/L	MCL	100
Selenium	µg/L	MCL	50
Silver	µg/L	SMCL	100
Thallium	µg/L	MCL	2
Vanadium	µg/L	NA	NA
EPA 245.1 - Mercury			
Mercury	µg/L	MCL	2

Notes:
MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; NA= No Limit Available,
µg/L = Micrograms per liter; mg/L = Milligrams per liter

Parameter	Units	Threshold Type	Threshold
EPA 300.0 - Inorganic Anions			
Bromide	mg/L	NA	NA
Fluoride (Natural Source)	mg/L	MCL	2
Nitrate (as NO3)	mg/L	MCL	45
Phosphate - Ortho	mg/L	NA	NA
Sulfate	mg/L	SMCL	250 (500)
SM 2130 B - Turbidity			
Turbidity - Laboratory	NTU	SMCL	5
SM 2320 B - Alkalinity			
Alkalinity - Total (as $CaCO_3$)	mg/L	NA	NA
Alkalinity - Bicarbonate (as $CaCO_3$)	mg/L	NA	NA
Alkalinity - Carbonate (as $CaCO_3$)	mg/L	NA	NA
Alkalinity - Hydroxide (as $CaCO_3$)	mg/L	NA	NA
Bicarbonate (as HCO_3)	mg/L	NA	NA
Carbonate Alkalinity	mg/L	NA	NA
Hydroxide Alkalinity	mg/L	NA	NA
SM 2340 C - Hardness			
Hardness - Total (as $CaCO_3$)	mg/L	NA	NA
SM 2510 B - Conductivity			
Specific Conductance	µmhos	SMCL	900 (1600)
SM 2540 C - Total Dissolved Solids			
Total Filterable Residue @ 180 ° C	mg/L	SMCL	500 (1000)
SM 4500-Cl D - Chloride			
Chloride	mg/L	SMCL	250 (500)
Measured in Field			
Oxygen - Dissolved	mg/L	NA	NA
pH - Field	pH units	NA	NA
Source Temperature C	C	NA	NA
Specific Conductance - Field	µS/cm	SMCL	900 (1600)
Turbidity - Field	NTU	SMCL	5

Notes:
MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; NA= No Limit Available,
µg/L = Micrograms per liter; mg/L = Milligrams per liter; NTU = Nephelometric Turbidity Units;
µmhos = Micromhos; C = Degrees Celsius; µS/cm = Microsiemens per centimeter

Parameter	Units	Threshold Type	Threshold
EPA 524.2 - Purgeable Organic Compounds			
1-1-1-2-Tetrachlorethane	µg/L	NA	NA
1-1-1-Trichloroethane	µg/L	MCL	200
1-1-2-2-Tetrachloroethane	µg/L	MCL	1
1-1-2-Trichloro-1-2-2-Trifluoroethane	µg/L	MCL	1200
1-1-2-Trichloroethane	µg/L	MCL	5
1-1-Dichloroethane	µg/L	MCL	5
1-1-Dichloroethylene	µg/L	MCL	6
1-1-Dichloropropene	µg/L	NA	NA
1-2-3-Trichlorobenzene	µg/L	NA	NA
1-2-3-Trichloropropane	µg/L	NA	NA
1-2-4-Trichlorobenzene	µg/L	MCL	5
1-2-4-Trimethylbenzene	µg/L	NA	NA
1-2-Dichlorobenzene	µg/L	MCL	600
1-2-Dichloroethane	µg/L	MCL	0.5
1-2-Dichloropropane	µg/L	MCL	5
1-3-5-Trimethylbenzene	µg/L	NA	NA
1-3-Dichlorobenzene	µg/L	NA	NA
1-3-Dichloropropane	µg/L	NA	NA
1-3-Dichloropropene (Total)	µg/L	MCL	0.5
1-4-Dichlorobenzene	µg/L	MCL	5
1-Phenylpropane	µg/L	NA	NA
2-2-Dichloropropane	µg/L	NA	NA
2-Chlorotoluene	µg/L	NA	NA
4-Chlorotoluene	µg/L	NA	NA
Benzene	µg/L	MCL	1
Bromobenzene	µg/L	NA	NA
Bromochloromethane	µg/L	NA	NA
Bromodichloromethane (THM)	µg/L	NA	NA
Bromoform (THM)	µg/L	NA	NA
Bromomethane	µg/L	NA	NA
Carbon Tetrachloride	µg/L	MCL	0.5
Chloroethane	µg/L	NA	NA
Chloroform (THM)	µg/L	NA	NA
Chloromethane	µg/L	NA	NA

Notes:
MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; NA= No Limit Available,
µg/L = Micrograms per liter; mg/L = Milligrams per liter

Parameter	Units	Threshold Type	Threshold
EPA 524.2 - Purgeable Organic Compounds (continued)			
Cis-1-2-Dichloroethylene	µg/L	MCL	6
Cis-1-3-Dichloropropene	µg/L	MCL	0.5
Dibromochloromethane (THM)	µg/L	NA	NA
Dibromomethane	µg/L	NA	NA
Dichlorodifluoromethane	µg/L	NA	NA
Dichloromethane	µg/L	MCL	5
Diisopropyl Ether	µg/L	NA	NA
Ethylbenzene	µg/L	MCL	300
Ethyl-Tert-Butyl Ether	µg/L	NA	NA
Hexachlorobutadiene	µg/L	NA	NA
Isopropylbenzene	µg/L	NA	NA
Methyl-Tert-Butyl-Ether (MTBE)	µg/L	MCL (SMCL)	13 (5)
Monochlorobenzene	µg/L	MCL	70
M-P-Xylene	µg/L	NA	NA
Naphthalene	µg/L	NA	NA
N-Butylbenzene	µg/L	NA	NA
O-Xylene	µg/L	NA	NA
P-Isopropyltoluene	µg/L	NA	NA
Sec-Butylbenzene	µg/L	NA	NA
Styrene	µg/L	MCL	100
Tert-Amyl-Methyl Ether	µg/L	NA	NA
Tert-Butyl Alcohol	µg/L	NA	NA
Tert-Butylbenzene	µg/L	NA	NA
Tetrachloroethylene	µg/L	MCL	5
Toluene	µg/L	MCL	150
Trans-1-2-Dichloroethylene	µg/L	MCL	10
Trans-1-3-Dichloropropene	µg/L	MCL	0.5
Trichloroethylene	µg/L	MCL	5
Trichlorofluoromethane	µg/L	MCL	150
Vinyl Chloride	µg/L	MCL	0.5
Xylenes (Total)	µg/L	MCL	1750

Notes:
MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; NA= No Limit Available,
µg/L = Micrograms per liter; mg/L = Milligrams per liter

Parameter	Units	Threshold Type	Threshold
EPA 525.2 - Organic Compounds			
4-4-DDD	µg/L	NA	NA
4-4-DDE	µg/L	NA	NA
4-4-DDT	µg/L	NA	NA
Acenaphthene	µg/L	NA	NA
Acenaphthylene	µg/L	NA	NA
Acetochlor	µg/L	NA	NA
Alachlor	µg/L	MCL	2
Aldrin	µg/L	NA	NA
Alpha-BHC	µg/L	NA	NA
Alpha-Chlordane	µg/L	MCL	0.1
Anthracene	µg/L	NA	NA
Atrazine	µg/L	MCL	1
Benzo (A) Anthracene	µg/L	NA	NA
Benzo (A) Pyrene	µg/L	MCL	0.2
Benzo (B) Fluoranthene	µg/L	NA	NA
Benzo (GHI) Perylene	µg/L	NA	NA
Benzo (K) Fluoranthene	µg/L	NA	NA
Benzyl Butyl Phthalate	µg/L	NA	NA
Beta-BHC	µg/L	NA	NA
Bromacil	µg/L	NA	NA
Butachlor	µg/L	NA	NA
Chlordane-Gamma	µg/L	MCL	0.1
Chlorobenzilate	µg/L	NA	NA
Chloroneb	µg/L	NA	NA
Chlorothalonil	µg/L	NA	NA
Chlorpyrifos	µg/L	NA	NA
Chrysene	µg/L	NA	NA
Cis-Permethrin	µg/L	NA	NA
DCPA Methyl Ester (Dacthal)	µg/L	NA	NA
DDVP	µg/L	NA	NA
Delta-BHC	µg/L	NA	NA
Di(2-Ethylhexyl)Adipate	µg/L	MCL	400
Di(2-Ethylhexyl)Phthalate	µg/L	MCL	4
Dibenzo (A-H) Antracene	µg/L	NA	NA

Notes:
MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; NA= No Limit Available,
µg/L = Micrograms per liter; mg/L = Milligrams per liter

Parameter	Units	Threshold Type	Threshold
EPA 525.2 - Organic Compounds (continued)			
Dieldrin	µg/L	NA	NA
Diethyl Phthalate	µg/L	NA	NA
Dimethyl Phthalate	µg/L	NA	NA
Di-n-Butylphthalate	µg/L	NA	NA
Di-n-Octylphthalate	µg/L	NA	NA
Endosulfan I	µg/L	NA	NA
Endosulfan II	µg/L	NA	NA
Endosulfan Sulfate	µg/L	NA	NA
Endrin	µg/L	MCL	2
Endrin Aldehyde	µg/L	NA	NA
Endrin Ketone	µg/L	NA	NA
EPTC (EPTAM)	µg/L	NA	NA
Ethyl Parathion	µg/L	NA	NA
Fluoranthene	µg/L	NA	NA
Fluorene	µg/L	NA	NA
Gamma-BHC (Lindane)- Total	µg/L	MCL	2
Heptachlor	µg/L	MCL	0.01
Heptachlor Epoxide (Isomer A)	µg/L	MCL	0.01
Heptachlor Epoxide (Isomer B)	µg/L	MCL	0.01
Hexachlorobenzene	µg/L	MCL	1
Hexachlorocyclopentadiene	µg/L	MCL	50
Isophorone	µg/L	NA	NA
Malathion	µg/L	NA	NA
Methoxychlor	µg/L	MCL	30
Metolachlor	µg/L	NA	NA
Metribuzin	µg/L	NA	NA
Molinate	µg/L	MCL	20
Naphthalene	µg/L	NA	NA
Pentachlorophenol	µg/L	MCL	1
Phenanthrene	µg/L	NA	NA
Prometryn	µg/L	NA	NA
Propachlor	µg/L	NA	NA
Pyrene	µg/L	NA	NA
Simazine	µg/L	MCL	4
Terbacil	µg/L	NA	NA

Notes:
MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; NA= No Limit Available,
µg/L = Micrograms per liter; mg/L = Milligrams per liter

Parameter	Units	Threshold Type	Threshold
EPA 525.2 - Organic Compounds (continued)			
Thiobencarb	µg/L	MCL (SMCL)	70 (1)
Trans-Nonachlor	µg/L	NA	NA
Trans-Permethrin	µg/L	NA	NA
Trifluralin	µg/L	NA	NA

Notes:

MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; NA= No Limit Available,
µg/L = Micrograms per liter; mg/L = Milligrams per liter

APPENDIX B - QUALITY ASSURANCE/QUALITY CONTROL

Laboratory Results

The Laboratory Quality Control (QC) report for Event 1 (October 2011) did not contain any data qualifiers. The analytical results, quality control information, and sample handling observations have been reviewed for both completeness and accuracy and are deemed acceptable for the purposes of this report.

The Laboratory QC report for Event 2 (January 2012) had data qualifiers for several test results including laboratory fortified matrix, matrix spike, laboratory fortified blank and ending calibration check which were outside of the acceptable recovery range. The chemicals associated with higher than acceptable range qualifiers were Benzo(a)Anthracene, Benzo(b)Fluoranthene, Chrysene, Methoxychlor, Endrin Ketone, Heptachlor Epoxide (Isomer A), and Pentachlorophenol. The chemical associated with a lower than acceptable range was 4,4'-DDT. None of these chemicals were detected in any of the surface water samples and therefore the data from this sampling event is considered acceptable for the purposes of this report.

The Laboratory QC report for Event 3 (March 2012) had QC qualifiers for several test results outside of the acceptable recovery range. The associated chemicals with QC test results above the acceptable range were: Diethylhexylphthalate, Di-n-Octylphthalate, and Dibenz[a,h]Anthracene. The chemicals associated with QC test results below the acceptable range were Atraxine, Bromacil, Propachlor, Simazine, Terbacil. None of these chemicals were detected in any of the surface water samples and therefore the data from this sampling event is considered acceptable for the purposes of this report.

No data were qualified or omitted for quality control/quality assurance purposes.

Field Results

All field meters were calibrated prior to use. The standard Groundwater Monitoring and Analysis’ Unit field protocol was followed for both calibration and the process of collecting the measurements. Field measured parameters were conducted with District field meters and in the case of dissolved oxygen a commercially available sampling kit. The measurements for dissolved oxygen were collected with a field kit that had an expired reagent (sodium thiosulphate) for Events 1 and 2. The dissolved oxygen measurements collected from the first two events were therefore omitted for quality control/quality assurance purposes.

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